WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005FL100B

Title: Development of an integrated methodology to assess vulnerability of groundwater to pathogen intrusion using GIS, remote sensing, neural networks and neuro-fuzzy methods

Project Type: Research

Focus Categories: Models, Management and Planning, Groundwater

Keywords: Ground Water Modeling (99), Bacteria (19), Virus (261)

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Principal Investigator:
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Abstract

Occurrence of well-drained sandy soils and karst features along with high rainfall makes Florida's ground water (GW), a major source of freshwater supply, vulnerable to contamination. In recent years, Florida has been one of the most common relocation destinations in the U.S. Florida's population grew from 4 million in 1955 to 16 million in 2000, the highest growth rate in the nation. As a result, we have two inevitable problems throughout Florida, i) increased amount of wastewater treatment and resultant sludge production, and (ii) increased number (and density) of septic systems. One of the dominant ways of sludge disposal is land application. Florida Department of Environmental Protection (FLDEP) has established detailed regulations for processing sludge before application and controlling the application of sludge to land. Since most processes used for complete pathogen/viral inactivation is not sufficient (EPA, 2003), landowners and the public as well as regulatory agencies are justifiably concerned about potential negative impacts of the potential spread of pathogens and resultant outbreaks. Additionally, in Florida, 3l% of the population is served by estimated 2.3 million septic systems. These systems discharge over 426 million gallons of wastewater per day into the subsurface soil environment. Inadequately treated sewage from septic systems can lead to

contamination of groundwater and poses a significant threat to drinking water and human health. There are no easy solutions to the sludge disposal or septic tank problems in Florida. Close connection between ground and surface water, common in Florida, means that pathogens found in surface water may find their way into GW and vice versa. Traditionally, state and county regulators used fixed setback distances for sludge application and septic tank locations for all geologic setting in their jurisdiction to protect our water resources. Study conducted for Ground Water Rule showed that setback distances were found to be quite variable, some were based on science, others were not (EPA, 2003). Conducting site-specific studies (on a case-by-case basis) to regulate entire Florida will be cost prohibitive. However, diverse soils, hydrogeology, land use and presence of karst in Florida clearly indicate that one size fits all mode of regulations for establishing setback distances might not be adequate. Therefore, there is a need to develop screening tool that (i) will provide reliable GW vulnerability estimates at varying watershed scales, (ii) require less extensive site-specific data, and at the same time, be robust when data are uncertain and incomplete, and (iii) can be easily updated.

We are proposing to develop a spatially explicit method that will provide a vulnerability map for an area based on similar hydrogeological, topographical, climatological, soils, preferential flow pathways and land use. This will be a useful environmental management tool to establish setback rules. This approach will attempt to strike a balance between expensive site-specific studies and broad-based one-size fits all policy. In a gross sense, information from soil surveys, hydrologeological parameters, and land use will be incorporated in a screening tool that will provide an indication of the level of risk a particular site may have to GW contamination by pathogen.

The specific objectives of this proposed research are l) to innovatively extend the GW vulnerability mapping at a large watershed scale by developing and adapting a neural networks (NN) and neuro-fuzzy models in a GIS platform, 2) to use geostatistical methods with well WQ data to generate surface maps showing microbial contamination potential, 3) to use VIROLU model that calculates mass of attenuation of microbes probabilistically, as a reference model for our methodology and finally, 4) to correlate predicted vulnerability map(s) developed using our methodology (NN, neuro-fuzzy and geostatistics) as well as VIROLU with existing microbial monitoring data from the various wells in a GIS for accuracy assessments. We have access through the Florida Aquifer Vulnerability Assessment (FAVA) project to data sets for 100 wells in the Hillsborough and adjacent counties of the South West Florida Water Management District (SWFWMD). A statistical comparison of the outputs from the models and kriged surfaces will be conducted with the field microbial contamination data for model validation. This research should contribute to the development of a robust but economically feasible screening tool for mapping spatially explicit risk of GW contamination to pathogens. Once the mapping tool is developed it will be available via the Internet to interested individuals, communities, regulatory agencies and policy makers and the methodology can be extended to other watersheds. Regulators, the public or businesses (e.g., licensed installers of septic tanks) can use these vulnerability maps for adopting effective and stringent setback distances. Watershed manager or county extension offices may use this map to implement Best Management Practices (BMPs).